Oregon
Theodore R. Kulongoski, Governor

Department of Human Services
Public Health Division
800 NE Oregon Street
Portland, OR 97232-2162
(971) 673-0971
Fax (971) 673-0979

May 19, 2008

Mr. Jim McKenna
Port of Portland & Co-Chairman, Lower Willamette Group
121 NW Everett
Portland, Oregon 97209

Mr. Robert Wyatt
Northwest Natural & Co-Chairman, Lower Willamette Group
220 Northwest Second Avenue
Portland, Oregon 97209

RE: (DRAFT) PCB in Breast Milk at Portland Harbor

Dear Messrs. Wyatt and McKenna:

The U.S. Environmental Protection Agency (EPA) has asked the Environmental Health Assessment Program (EHAP, formerly SHINE) to develop recommendations on how to address the health risks for infants exposed to PCBs in breast milk in the context of the many health benefits of breast feeding. This health consultation is designed to answer their request.

Background

Resident fish species collected within Portland Harbor have been found to contain levels of polychlorinated biphenyls (PCBs) that may pose a risk to human health. For example PCB levels of up to 4.5 and 6.5 mg/kg have been detected in smallmouth bass tissue and carp tissue samples collected from Portland Harbor respectively. Consuming resident fish species from the harbor has been declared a public health hazard, and correlated fish advisories have been issued[1]. The current fish advisory includes the following clause: "Women of childbearing age, especially women who are pregnant, thinking about getting pregnant or nursing, infants and children and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor. Examples of resident fish include bass, carp and bullhead catfish."[1]

Despite the current advisory, subsistence fishing from the harbor may occur, although the extent to which it occurs is unknown. The PCB content of breast milk is closely related to the concentration of PCBs in the adipose tissue of the mother. A mother eating resident fish species from Portland Harbor over a period of time would be expected to accumulate a significant amount of PCBs in her adipose tissue. Therefore, it is plausible to assume that an infant consuming the breast milk of a mother who has a significant body burden of PCBs could receive a relatively high dose of PCBs.

The breast feeding exposure pathway for environmental contaminants presents unique challenges to the health/risk assessor and public health officials. In most health/risk assessments, the exposure medium is considered only a delivery vehicle for the contaminant of concern. In the case of breast milk, however, the exposure medium contains a multitude of healthful compounds that have been well documented to produce measurable health benefits. In fact, not breast feeding is considered a risk factor for several acute and chronic health conditions. Therefore, treatment of this exposure pathway requires not a simple assessment of risk, but rather, a balancing of the risks associated with contaminant exposure against the well documented health benefits of breast feeding. To further complicate this process, there is no accepted threshold value for PCBs in breast milk. In the absence of such thresholds, local, state, and federal health agencies struggle to formulate an appropriate public health response to this potential threat.

Discussion

Health benefits of breast feeding-

Breast feeding has been shown to be the healthiest option for infants under most conditions. Breast milk is an inexpensive, ideally balanced source of nutrition[2]. The infant immune system is matured and bolstered by breast milk components. Immunoglobulin A (IgA) in breast milk reduces the uptake of dietary antigens, protecting against development of food allergies[3]. IgA in breast milk also protects the infant against microbes from the maternal gut and prevents microbes from binding to the intestinal mucosal surface[4]. Breast milk also has anti-inflammatory properties[3], stimulates maturation of the intestinal epithelium and enhances the protective character of the intestinal mucosa[5]. This overall enhancement of immune function means reduced risk of multiple types of infectious disease for the infant.

Breast feeding is also associated with improved IQ scores and neurological development and reduced risk of SIDS, type I and type II diabetes, leukemia, obesity, asthma, and high cholesterol[2]. Recent research suggests that exclusive breast feeding may reduce the risk of celiac disease[6]. There are also psychological benefits to the improved mother-infant bonding that accompanies consistent breast feeding. Overall, non-breast-fed babies have a 21 percent higher mortality rate than breast-fed babies[2].

Mothers who breast feed also enjoy health benefits including reduced postpartum bleeding, reduced risk of breast and ovarian cancer, easier loss of excess adipose accumulated during pregnancy, and enhanced psychological well-being with increased bonding between mother and child. Breast feeding also benefits society by reducing health care costs (healthier babies), increasing worker productivity (children sick less often), and introduces less waste into the environment[2].

PCBs in breast milk and children's health

Background concentrations of PCBs in breast milk vary by region and culture, but overall, these concentrations appear to be decreasing over time. The Agency of Toxic Substances and Disease Registry (ATSDR) suggests that 0.247 μg PCB/g-lipid might be the best current estimate.[7] PCB concentrations as high as 10-15 μg/g-lipid have been reported in instances where mothers were occupationally exposed[8]. People who consume large amounts of PCB-contaminated fish have also been shown to have higher breast milk PCB concentrations.[7] Studies found a negative correlation between PCB concentrations in the breast milk of nursing mothers and the health of their children.

The adverse health effects in children associated with increasing concentrations of PCBs in their mothers' breast milk included deficits in neurobehavioral function, alterations within the immune system, and altered thyroid function (see table 1).[7]

In most cases, toxicity was attributed to prenatal exposure to PCBs. One study, known as the "Dutch PCB/Dioxin Study," compared the neurological performance of children exposed to PCBs only prenatally with that of children exposed prenatally and postnatally via breast milk. While children consuming milk containing higher PCBs fared worse than children consuming milk with lower levels, all groups of breast-fed children fared better than bottle-fed children. The lowest performing children had been exposed to high levels of PCBs prenatally but had been formula fed after birth. This seems to suggest that breast feeding, even with PCB-contaminated milk, served to counter the negative effects of prenatal PCB exposure[9,10]. The studies cited in this report conclude that, even at the highest breast milk PCB levels measured, the health benefits of breast feeding still outweigh the risks associated with contaminant exposure.

The highest PCB concentration measured in breast milk that EHAP was able to find in the literature was 15 μg/g-lipid. While this study by Hara[8] identified more health effects in children who breast-fed for more than 5 months from mothers with extensive occupational PCB exposure histories, these effects were self-reported, and none of the children were diagnosed as having PCB poisoning by health care professionals. An additional limitation of this study is that health effects were compared based on the mothers' occupational exposure history rather than on breast milk PCB concentrations.

How does the estimated PCB dose to infants via breast milk compare with dose responses observed in animal studies?

The doses of PCBs that a breastfeeding infant may be expected to receive, given breast milk PCB concentrations measured in the literature, are presented in table 1 (see appendix A for calculations and exposure assumptions). These doses range from 0.0011 to 0.0048 mg/kg/day and are 36-160 times higher than ATSDR's minimal risk level (0.00003 mg/kg/day) for PCB exposures that last between 15 and 364 days. These doses are slightly lower than that shown to cause health effects in monkeys (0.005 mg/kg/day). Health effects that occurred in monkeys at 0.005 mg/kg/day include altered finger and toe nails and nail beds, inflammation of eye-lid glands, and decreased immunity.[7]

Risk vs. Benefit-

If a PCB dose of 0.001 mg/kg/day were estimated in any other media, EHAP would recommend that citizens reduce or eliminate their exposure to that medium. However, PCB exposure via breast milk necessarily follows additional prenatal exposures during critical developmental windows. Studies cited here suggest that breast milk, even with significant PCB contamination, may serve to reverse or stabilize developmental lesions initiated by prenatal exposure[9,10].

To date there has been no biomonitoring to determine the breast milk PCB concentrations of women who consume fish from Portland Harbor. However, tissue PCB concentrations in the fish from Portland harbor have been measured. PCB contamination in Portland Harbor fish is similar to that found in fish at other sites where corresponding breast milk concentrations have been found to be elevated.[7]

The primary goal for environmental and health agencies should be to reduce PCB exposure to women of childbearing age. As PCB-contaminated fish can be a major source of maternal PCB body burdens, these findings reinforce the importance of the current fish advisory for Portland Harbor issued by Oregon's Office of Environmental Public Health (OEPH)[1]. However, the recommended course for infants who have already had prenatal exposure to PCBs is clear. Breast feeding is best for infants regardless of PCB levels in the milk.

Affected population and EHAP activities-

In regards to the Portland Harbor superfund site, the affected population (subsistence fish eaters who are pregnant, planning on becoming pregnant or nursing) includes hard-to-reach ethnic communities. Since 2002, EHAP has worked with community-based organizations and local agencies to identify affected populations and provide information to them about safe fish consumption. EHAP encountered several barriers in this effort. The primary barrier was a lack of resources to locate and build relationships with high fish consumers. Other barriers included communicating information in the appropriate language. While the current findings reinforce the importance of conducting this kind of outreach, EHAP does not currently have the resources to continue these time-intensive efforts.

Conclusions

-For lipophilic environmental contaminants such as PCBs, the nursing infant receives the highest dose of contaminant and is the population most sensitive to that contaminant.

-Breast milk containing high background PCB concentrations could result in doses to infants as much as 160 times higher than the minimal risk level for PCBs. However, due to the significant benefits of breast milk, breast feeding should still be recommended.

-Elevated levels of PCBs in breast milk indicate significant prenatal exposure to PCBs.

-The current fish advisory is protective of nursing infants as long as their mothers adhere to it. (See current advisory at: http://www.oregon.gov/DHS/ph/envtox/fishconsumption.shtml#Portland)

-Data gaps about actual exposure and resulting body burdens from these contaminants at Portland Harbor exist. Biological monitoring of breast milk from women who eat fish from Portland Harbor would help to fill this data gap.

-Because remediation will not likely reduce PCB levels below health-based guidelines for several decades, effective risk mitigation depends on adherence to current fish advisories. Lack of resources for community outreach and education regarding fish advisories limits the effectiveness of those advisories to protect public health.

Recommendations

-The Lower Willamette Group (LWG) should fund the OEPH to conduct a sustained community outreach campaign directed towards women of childbearing age who are high fish consumers. This campaign should promote breast feeding as the healthiest option for infants regardless of the mother's exposure scenario, promote fish as a healthy source of nutrition, but discourage eating resident fish species from Portland Harbor such as bass, carp, and catfish. To effectively encourage these health-protective behaviors, the outreach campaign should:

- Identify affected populations (i.e., ethnic or cultural groups that report frequent consumption of locally caught fish)
- Characterize affected populations as to:
    - Effective communication channels
    - Beliefs, attitudes, and knowledge about breast feeding and environmental contaminants in the fish they consume
    - Fishing practices (species and parts of fish consumed, locations fished, frequency, preparation methods)
- Develop culturally appropriate strategies and messages to encourage desired behaviors in target populations
- Implement the strategies and disseminate the messages that have been developed in the manner determined to be most effective for target populations
- Evaluate effectiveness of the campaign by assessing behavior changes in target populations

-EPA and LWG should include language in the baseline human health risk assessment encouraging women to continue breast feeding regardless of contaminant exposure. This language should include information on the well-documented health benefits of breast feeding.

-EHAP strenuously encourages all women of childbearing age to abide by the current fish advisories for Portland Harbor by avoiding resident fish species from Portland Harbor. (See current advisory at: http://www.oregon.gov/DHS/ph/envtox/fishconsumption.shtml#Portland)

-EHAP recommends that all women continue to breastfeed their infants regardless of exposure situation unless directed otherwise by their physician.

Table 1[a]
Health Effects in Human Infants Associated with PCBs in Breast Milk

Study	Mean Breast Milk PCB Conc. (μg/g-lipid)	$ADD_{nc\text{-}infant}$[b] (mg/kg/day)	Observed Health Effects[c]	Comparison with Formula-fed Controls
Michigan Cohort	0.87 (fisheaters) 0.62 (nonfisheaters) Total PCBs	0.0023 (fisheaters) 0.0016 (nonfisheaters)	Reduced birth weight, head circumference, and gestational age in newborns. Neurobehavioral alterations in newborn and older children.	Deficits correlated with prenatal exposure but not postnatal exposure via breast milk.
Dutch Cohort	0.62 Total PCBs	0.0016	Reduced birth weight. Reduced growth during first 3 months in formula-fed, but not breast-fed children. Neurobehavioral alterations and changes in T-lymphocyte subpopulations and thyroid hormone levels in infants.	Slight increased incidence of mild hypotonia and neurological function in children breastfed with high PCBs relative to formula fed, but mental performance was enhanced with breastfeeding regardless of PCB contamination. Minor effects associated with postnatal exposure via breast milk resolved by 18 months of age.
German Cohort	0.43 Sum of PCB congeners[d]	0.0011	Neurodevelopmental and thyroid hormone alterations in infants.	Breast-fed children did better than formula-fed in all parameters tested.
Inuit Infant Study	0.62 Sum of PCB congeners[d]	0.0016	Immunologic alterations.	No difference in immunological parameters between breast fed and formula fed infant
North Carolina Cohort	1.8 Sum of PCB congeners[d]	0.0048	Neurobehavioral alterations in infants	No comparison.
Intermediate-duration MRL[e] for Aroclor 1254:		**0.00003 mg/kg/day**		

Notes:

a) Adapted from Table A-1 in ATSDR's Toxicological Profile for PCBs[7]

b) Non-cancer Average Daily Dose to infant via breast milk. Parameter not reported in studies, but doses were calculated for infants nursing from mothers with mean breast milk PCB concentrations reported. This exposure pathway is not applicable to formula-fed infants. (See Appendix A for calculations and assumptions). It is important to note that any exposure via breast milk follows an unquantified prenatal exposure.

c) No distinction between effects due to prenatal exposure and effects due to postnatal exposure via breast milk (unless otherwise noted in table).

d) PCB value is the sum of three non-dioxin-like congeners (PCB 138, PCB 153, and PCB 180).

e) MRL = minimal risk level for intermediate-duration exposure (two weeks to one year).

Sincerely

David Farrer, BS, MS, PhD
Public Health Toxicologist
Environmental Health Assessment Program
Office of Environmental Public Health
Oregon Public Health Division
Department of Human Services
800 NE Oregon St., Ste. 640
Portland, OR 97232-2162
Tel. 971-673-0971
Fax 971- 673-0979
david.g.farrer@state.or.us

---

[1] Agency for Toxic Substances and Disease Registry. Public Health Assessment: Portland Harbor. U.S. Department of Health and Human Services, Atlanta, GA; 2006.
[2] Department of Health and Human Services, National Women's Health Information Center (2008) website http://www.4women.gov/breastfeeding/index.cfm?page=227
[3] Kelly D. and Coutts A.G.P. (2000). Early nutrition and the development of immune function in the neonate. *Proceedings of the Nutritional Society,* **59,** 177-185.
[4] Hanson L.A., Korotkova M., Lundin S., Haversen L., Silfverdal S.A., Mattsby-Baltzer I. (2003). The transfer of immunity from mother to child. *Annals of the New York Academy of Sciences,* **987,** 199-206.
[5] Newburg D.S. (2005). Innate immunity and human milk. *Journal of Nutrition,* **135,** 1308-1312.
[6] Chertok I.R. (2007). The Importance of Exclusive Breastfeeding in Infants at Risk of Celiac Disease. *MCN. The American Journal of Child and Maternal Nursing,* **32,** 50-54.
[7] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polychlorinated Biphenyls (2000). U.S. Department of Health and Human Services, Atlanta, GA.
[8] Hara I. (1985). Health Status and PCBs in Blood of Workers Exposed to PCBs and of Their Children. *Environmental Health Perspectives,* **59,** 85-90.
[9] Huisman M., Koopman-Esseboom C., Fidler V., Hadders-Algra M., et al. (1995). Perinatal Exposure to Polychlorinated Biphenyls and Dioxins and its Effect on Neonatal Neurological Development. *Early Human Development,* **41,** 111-127.
[10] Koopman-Esseboom C., Weisglas-Kuperus N., de Ridder M.A.J., Van der Paauw C.G., et al. (1996). Effects of Polychlorinated Biphenyl/Dioxin Exposure and Feeding Type on Infants' Mental and Psychomotor Development. *Pediatrics,* **97,** 700-706.

Apendix A
Calculation of Dose to Infant

Starting with PCB concentrations measured in breast milk, the average daily dose to infants for non-cancer effects was calculated as follows:

$$ADD_{nc\text{-}infant} = \frac{C_{milkfat} \times IR_{milk} \times f_3 \times f_4}{BW_i}$$

Where:

$ADD_{nc\text{-}infant}$	= Average daily dose for breast-feeding infant (mg/kg/day)
$C_{milkfat}$	= Concentration of PCBs measured in milk fat (µg/g-lipid)
IR_{milk}	= Ingestion rate of breast milk (0.69 kg-milk/day)[1]
f_3	= Fraction of breast milk that is fat (0.04 kg-lipid/kg-milk)[1]
f_4	= Fraction of ingested PCB that is absorbed (0.9)[1]
BW_i	= Body weight of breast-feeding infant (9.4 kg)[1]

[1] Assumptions and calculations are modified from Table C-3-2 of the U.S. Environmental Protection Agencies combustion guidance. (U. S. EPA. *Human Health Risk Assessment Protocol for Hazard Waste Combustion Facilities.* (EPA 530-R-05-006, September 2005.))